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The effect of the cooking method on rainbow trout (*Oncorhynchus mykiss*) fillets

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ABSTRACT

Fish is nutritious seafood and contains protein with high biological value and essential nutrients for the human body. In Iran, the fish *Oncorhynchus mykiss* is locally known as Ghezelala and is a commercial fish species. Different methods were used to process the fish: boiling, frying in sunflower oil and grilling. This research investigated on effect of various cooking methods on proximate pH and cooking loss of fresh fish (*Oncorhynchus mykiss*). The highest and lowest values for protein were found in fish processed using grilling (18.51%) and frying (16.52%), respectively ($p < 0.05$) compared to the fresh sample (18.20%). The fat content of the fried sample showed significantly highest (5.16%) ($p < 0.05$), while the lowest fat content was found for the boiled sample (20.57%) compared to the fresh fat (24.36%) ($p < 0.05$). Comparing the loss percentage of samples in different cooking methods showed that the boiled sample had the lowest value (25.46%) and the fried sample with the highest value (45.02%) ($p < 0.05$). pH value in the boiled sample was the highest (6.74%), while the grilled sample had the lowest (6.63) compared to the fresh sample (6.54). The highest energy value was found for the fried sample (578.48 kcal/100g), and the lowest was for the boiled sample (269.29 kcal/100g). The results suggest that the boiled and grilled fish found higher nutritional quality due to the relatively high protein content, the most needed nutrients. The results also showed that all cooking methods did not significantly affect in mineral content of the fresh fish.

Keywords: cooking methods, *Oncorhynchus mykiss*, nutrients, cook loss, pH

INTRODUCTION

One of Iran's most important and desirable farmed aquatic animals was the rainbow trout (*Oncorhynchus mykiss*). Its production in Iran was 853 tons in 1992, about a 32% increase. This fish species has high popularity due to its ability to farm in Iran compared to other aquatic animals. The sale of this fish species as fresh and live since 1997 has increased. This fish species is rich in fat. This cold-water fish is farmed in the cold areas of Iran, is readily available for consumption in Iran, and has many consumers. Rainbow trout can be caught fresh from fish ponds.

Iran's three standard fish cooking methods are boiling, frying, and grilling. After cooking in recent decades, people have kept fish in the refrigerator in the refrigerator for consumption. In this article, we investigated and compared the nutritional and energy values of rainbow trout with three methods of cooking, grilling, frying, and boiling, after storage for two days in the refrigerator, then measured the factors of cooking loss, pH, moisture, ash, fat, and protein contents [2].

Fish is a nutritious food, an excellent source of animal protein needed in the human diet, and is also rich in essential vitamins and minerals [1]. In Iran, fish is not eaten raw but is processed using various cooking methods such as roasting. Frying and boiling mainly improve the taste [2] and kill microorganisms. Pathogenic [3]. However, many studies have shown that different cooking methods always affect the nutritional value of fish. In particular, vitamins, flavourings, and polyunsaturated fatty acids [4], [5].

The present study aimed to investigate on proximate composition and physicochemical properties of fresh *Oncorhynchus mykiss* and fried, grilled, and boiled samples.



Figure 1 Rainbow trout (*Oncorhynchus mykiss*).

Scientific Hypothesis

The nutritional quality of processed fish depends on the method and thermal conditions of production and the preservation of fish nutrients in the processed product.

MATERIAL AND METHODOLOGY

Samples

This research work was carried out in 2021 at Behbahan Khatam Alanbia University of Technology, Iran. The fish were caught in Shiraz, Iran. All samples were packaged and stored in a refrigerator at 4 °C for two days. All samples were placed on ice and were transferred to the laboratory.

Chemicals

All chemicals were purchased by Shiraz Company in Iran and were of analytical grade quality.

Animals and Biological Material

The Latin name of the fish species was rainbow trout, and the scientific name was *Oncorhynchus mykiss*. Sunflower oil is the non-volatile oil pressed from sunflower seeds (*Helianthus annuus*).

Instruments

The charcoal, water, meter, scale, oven, electric furnace, Chinese container, Petri dish, distilled water, homogenizer, and pH meter were used in this research.

Laboratory Methods

The three cooking methods (boiling, grilling, and frying) are used in the present research.

Description of the Experiment

Sample preparation:

The fish was filleted with a knife; then, the fillets were weighed by a scale. The weight of the fillets was 1.235 kg. The fillets were divided into four parts A, B, C, and D.

Design of the experiment:

The fish fillets were divided into four groups: Part A, with a weight of 262.4 g, was considered for the control treatment, packaged without processing, and stored in the refrigerator at 4 °C. Part B, with a 425g, was grilled with charcoal heat for 10 min. The sample was cooled for 25 min at an ambient temperature of 24 °C. The weight of sample B was measured after processing (297.8 g). Part C, weighing 265g C, was fried in 200 ml of liquid sunflower oil at 180 °C for 12 min. The sample was cooled at an ambient temperature of 24 °C for 25 min. The weight of sample C was measured after processing, and its weight was 145.7 g. Part D, with a weight of 260 g, was boiled in 500 ml of boiling water at 98 °C for 20 min. The separation of fat drops in boiling water was observed during cooking. The sample was then cooled at an ambient temperature of 24 °C for 25 minutes. The weight of sample D was measured after processing (193.8 g).

The following formula calculated the cooking loss percentage:

The amount of initial raw weight of fillet – sample weight after each cooking process / the amount of raw weight × 100

Biometrics: Fish length: 53 cm. Fish width: 16 cm. Fish weight 2155 g.

Moisture, protein, fat, ash, and pH in the fresh and cooked fish were analysed according to AOAC [6]. All analyses were performed in triplicate.

Each sample was placed in the container. Samples were placed in an oven at 105 °C for 90 min. The samples were moved from the oven and weighed with a scale. Measurements continued until the weight remained constant; then, the samples were placed in the oven again for 15 min and weighed. There was no weight change.

The moisture content was calculated as follows according to 10g each sample:

$$A1_{\text{moisture}} = 10 - 3.9968 = 6.0032$$

$$A2_{\text{moisture}} = 10 - 4.5637 = 5.4363$$

$$B1_{\text{moisture}} = 10 - 4.2365 = 5.7635$$

$$B2_{\text{moisture}} = 10 - 4.6230 = 5.3770$$

$$C1_{\text{moisture}} = 10 - 7.3245 = 2.6755$$

$$C2_{\text{moisture}} = 10 - 6.8367 = 3.1633$$

$$D1_{\text{moisture}} = 10 - 4.1517 = 5.8483$$

$$D2_{\text{moisture}} = 10 - 3.6958 = 6.3042$$

PH measurement

The 5 g of each sample was measured, and then the pH value was measured. All samples were crushed separately by a homogenizer and mixed with 45 ml of distilled water. The pH value of each sample was measured by a pH meter model PHS-550 digital device made in China.

Number of samples analysed: 24 samples.

Number of repeated analyses: All chemical analyses were conducted in triplicate.

Number of experiment replication: 2 times.

Statistical Analysis

Data analysis was done in three replications. Duncan's mean comparison test was used at a 5% level. The calculations were performed using SPSS 19 software(IBM, USA). Results were expressed as the mean of triplicate trials. Data were analysed by one-way analysis of variance on the means of values ($p < 0.05$).

RESULTS AND DISCUSSION

The study results are present in Figures 2, 3, 4, 5, 6, 7 and 8.

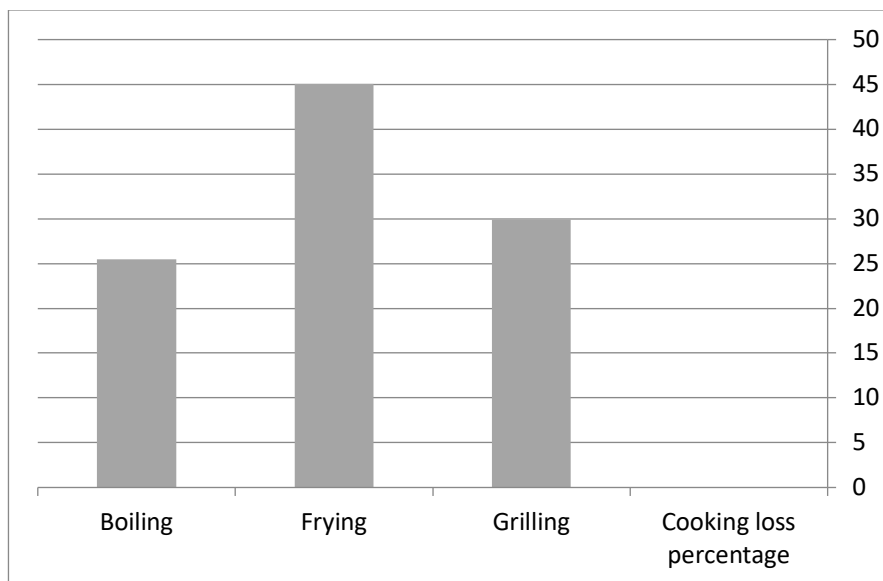


Figure 2 Comparison of cooking loss percentage of samples in different processing methods.

The pH of sample A (control) was 6.54. The pH of sample B (grilled) was 6.63. The pH of sample C (fried) was 6.66. The pH of sample D (boiled) was 6.74. The cooking loss percentages in all methods were below respectively.

$$B_{\text{cooking loss percentage}} = (425 - 297.8) / 425 \times 100 = 29.93\%$$

$$C_{\text{cooking loss percentage}} = (265 - 145.7) / 265 \times 100 = 45.02\%$$

$$D_{\text{cooking loss percentage}} = (260 - 193.8) / 260 \times 100 = 25.46\%$$

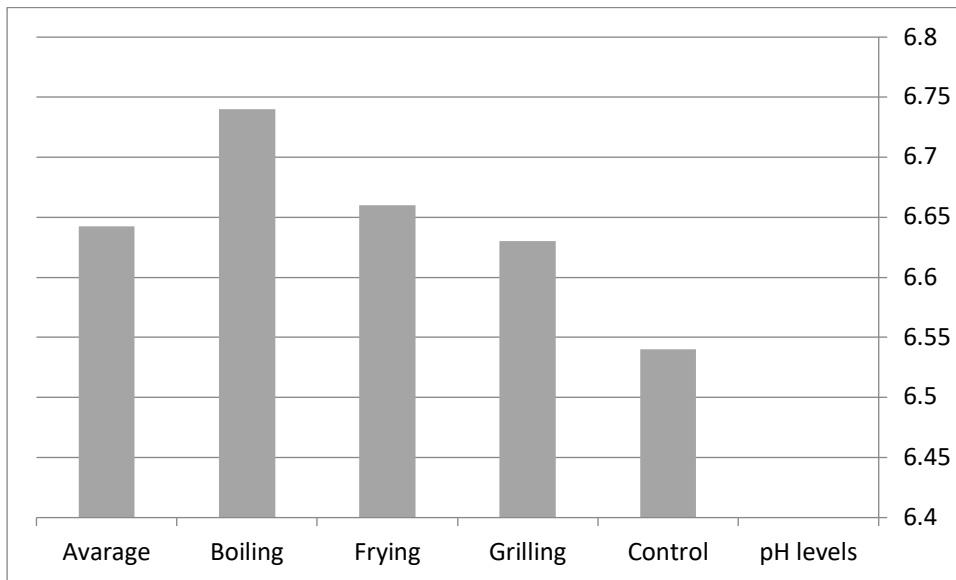


Figure 3 Comparison of pH values of samples in different processing methods.

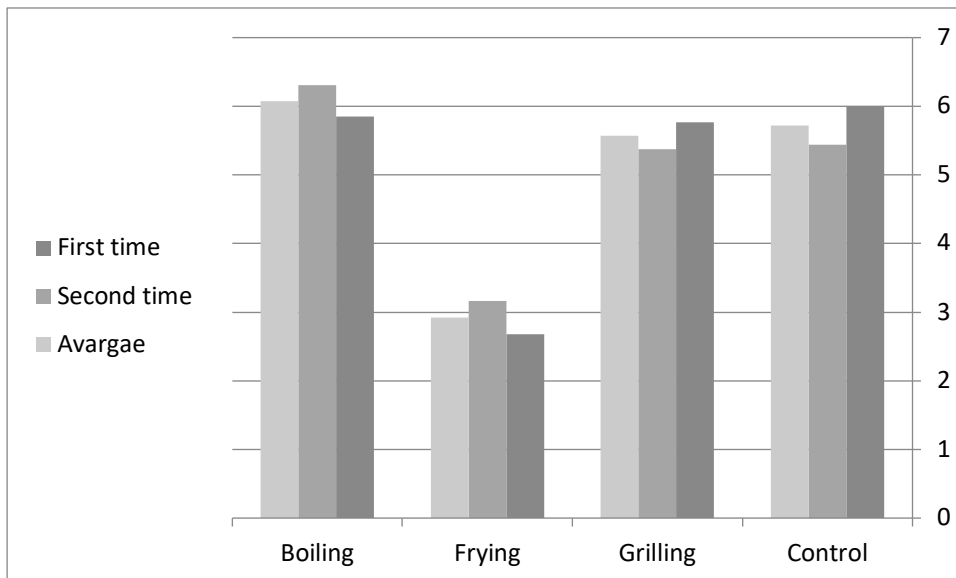


Figure 4 Comparison of moisture content of fish fillets in different processing samples.

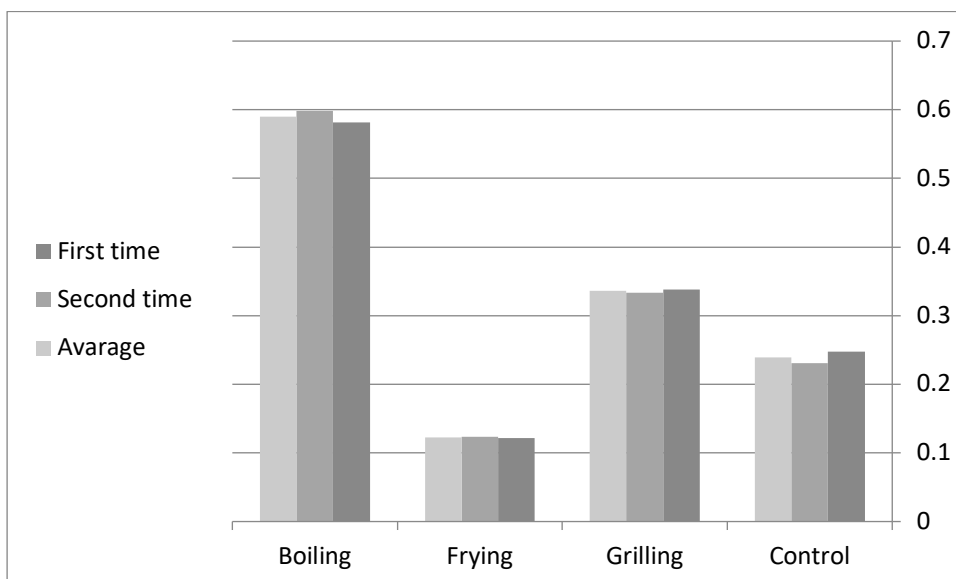


Figure 5 Comparison of ash content in fish fillets in different processing samples.

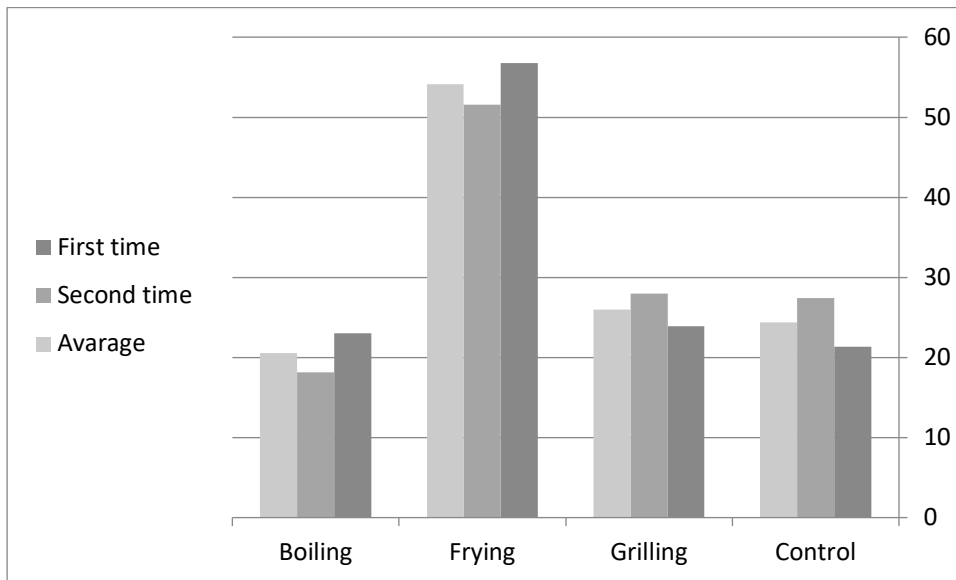


Figure 6 Comparison of fat content in fish fillets in different processing samples.

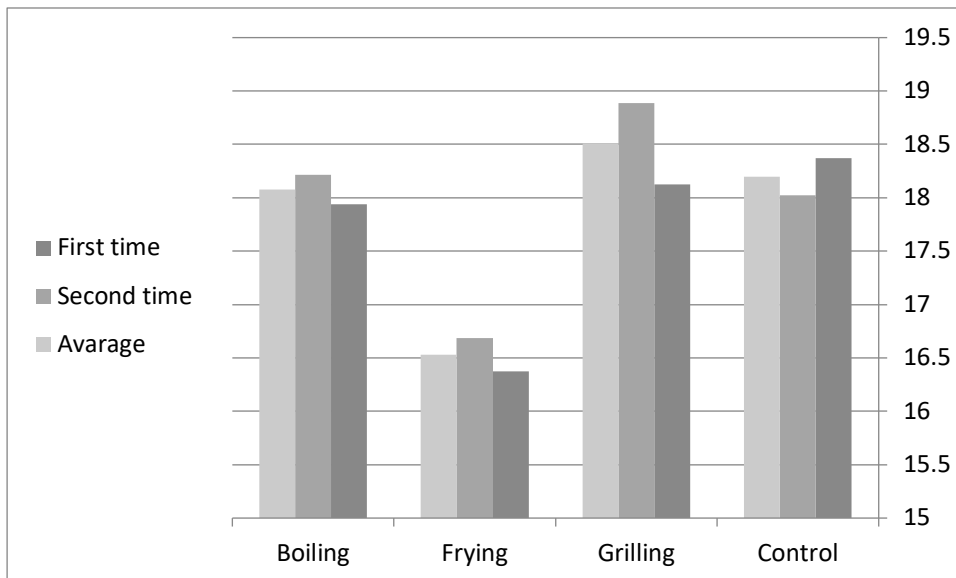


Figure 7 Comparison of protein content in fish fillets in different processing samples.

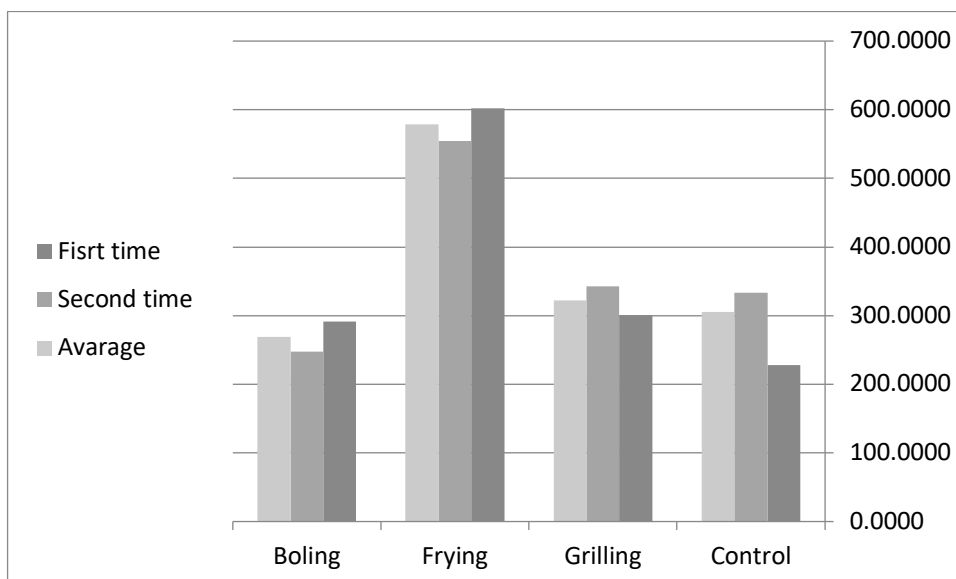


Figure 8 Comparison of energy value (Kcal) in fish fillets in different processing samples.

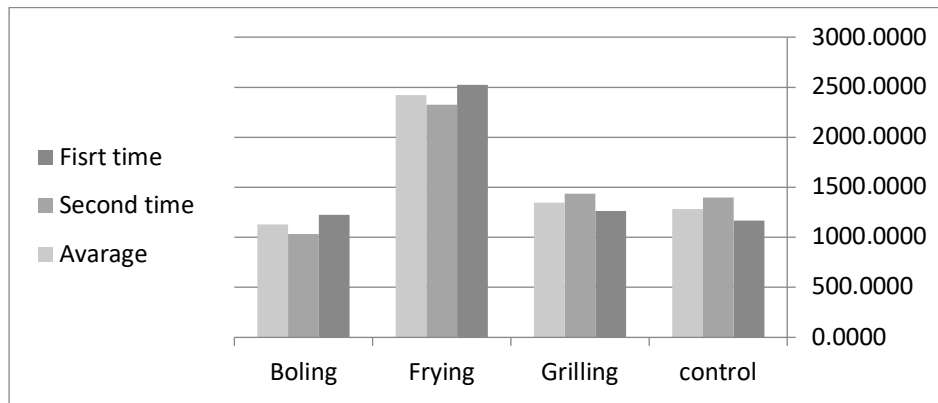


Figure 9 Comparison of energy value (KJ) in fish fillets in different processing samples.

Loss of cooking was found in different methods significant respectively: fried>grilled>boiled, respectively ($p < 0.05$). The boiling process was better from the point of economical compared to the other samples.

The pH value of the samples fillets was found to be significant in different methods, respectively: boiled>fried>grilled>control ($p < 0.05$).

The fat percentage and energy value were significantly different in fried fish than in other methods and control samples. Fat loss during cooking was observed the lowest percentage and energy value of fat in the boiling method. Due to cooking, fat content changed and was observed in the fried sample more than in a boiled sample, while in the boiled sample was more than in a grilled sample. In samples, energy levels and fat percentage were observed, significant respectively, fried>control>grilled>boiled ($p < 0.05$).

There was no significant difference in protein percentage and energy value in different cooking methods compared to the control sample ($p < 0.05$). The percentage and energy value of protein in the grilling method was due to two days of storage in the refrigerator, which was even better than the control sample due to less denatured protein than the control sample. The samples' energy level and protein percentage were observed significant: grilled>control>boiled>fried ($p < 0.05$).

The total energy of the fish fillet (total energy values of fat and protein) was observed, respectively: fried>grilled>control>boiled. Fried fish contains a significant amount of fat recommended for children who need more energy ($p < 0.05$). Boiled fish has a lower energy level and fat content, so for people on a weight loss diet or with high blood fats.

The grilled preserved protein and energy levels better against denaturation over time and is recommended for athletes who consume more protein in their diet.

Because of the optimum ratio of fat to protein compared to the control sample and the total energy of the samples, it can be concluded that the grilling method for the studied fish for healthy nutrition after two days of cold storage was the most suitable method processing.

Significantly changes in the fish nutrient contents were reported in various cooking methods ($p < 0.05$). Therefore, these cases reflect many previous reports that the type of processing leads to changes in the food quality of fish [2], [4], [5]. Both fish nutrition and quality are related to macronutrient composition [7].

The boiled fish contains high protein significance ($p < 0.05$). because, during cooking, denatured proteins are not mainly lost [8]. Al-Jeddah et al. [9] also reported that fish muscle is more digestible than other animal proteins due to the smaller amounts of connective tissue. Due to the need for essential amino acids [10] – boiled fish is superior to other methods due to its higher protein content.

The frying and boiling methods showed the lowest and highest moisture content, respectively, compared to the fresh fish. Due to the extended contact with boiling steam and water, the moisture content in fish in the boiling method was highest [11].

The ash contents in various cooking methods except frying indicated that this fish species was rich in minerals ($p < 0.05$). Minerals are always not destroyed by cooking heat processes [12]. The duo to frying process causes some minerals (from the scales and spine) to enter the fat, and the mineral content in fried fish was low [13] and [14].

Physicochemical quality properties of processed fish

One of the good indexes for quality assessment of fish fillets is pH value. It is necessary to determine fish texture quality [15]. The changes in pH value of raw and cooked fish in different methods are presented in Figure 2. The pH value showed a slight increase after the cooking process. The recorded pH value of raw, fried, boiled, and grilled fish was 6.54, 6.66, 6.74, and 6.63, respectively.

These results are similar to those of Bett and Dionigi [16]. They reported that the decomposition of nitrogen components after also catching bacterial growth [17] increased the pH of fish fillets. The acceptance limit of fish pH value was determined between 6.8 and 7, while values above 7 were spoilage indices [18], [19]. The duo to breakage of hydrogen bond and electrostatic interactions, pH value in boiled processed *Oncorhynchus mykiss* fillets increased from 6.54 (raw) to 6.74 [20].

The cooking loss percentage in fish fillets increased with time and temperature, although most cooking loss occurs during primary heating. Similar results were found for Atlantic fish (*Gadus morhua*) [21], pink salmon (*Oncorhynchus gorbuscha*) [22], and blue oyster (*Mytilus edulis*) [23]. Loss of cooking and then shrinkage of fish muscle is generally due to denaturation of heat-induced protein and consequent shrinkage of myofibrillar protein. High heat time and degrees lead to more denaturation, resulting in more cooking losses and shrinkage, which agreed with the present study results, which showed the frying temperature of fish in oil (180 °C) was higher than grilling on charcoal and boiling in water (98 °C). As a result, the cooking loss in the fried sample was higher than in other samples.

Here, we suggest that during *post-mortem* proteolysis during cold storage, myofibrils and sarcomeres decompose slowly, resulting in less muscle shrinkage during heating and cooking loss. The effect of fish freshness on quality characteristics such as cooking loss should not be ignored. Loss of cooking and shrinkage of fish fillets is not only affected by the intensity of heat treatment but also by cold storage conditions before reheating, and the mechanism behind this may be due to post-mortem proteolysis, which leads to less shrinkage when heated, which is associated with contraction [24].

Some researchers reported that frying was the only cooking method to change the fatty acid content of the rainbow trout fillet. These results suggest that the cooking methods that optimize n-3 PUFA consumption of rainbow trout are baking, grilling, microwaving, or frying pans in CO, CaO, or PO [25].

In general, protein and ash content increased after cooking in all evaluated methods ($p < 0.05$). According to Ersoy and Ozren, the increase in protein, fat and ash content can be explained by the decrease in moisture [26]. These results are similar to the findings of other researchers [27], [28].

CONCLUSION

The cooked fish in the water had the highest content of nutrients, especially protein, which may indicate that food production contains high-quality nutrients. The highest energy value was found for the fried sample (578.48 kcal/100g), and the lowest was for the boiled sample (269.29 kcal/100g). However, boiled fish containing more moisture may lead to low shelf life, because water promotes microbial spoilage. Fish oil is suitable for healthy nutrition. Therefore, The fried fish indicated a longer shelf life due to the highest amount of fat with the lowest moisture, although soft minerals are desirable. There was no difference in mineral content for boiled and grilled fish, except for the grilled sample, which had lower moisture, indicating a cooked product with better shelf life. All cooking methods except frying had minor mineral changes, which may show that the cooking process does not affect the mineral content of the fish, except for the frying. Comparing the cooking loss percentage of samples in different cooking methods showed that the boiled sample had the lowest value (25.46%) and the fried sample with the highest value (45.02%). The cooking methods may decrease the nutrient content, indicating caution in processing fresh fish. Although fish is a nutrient-rich food, the most important component of fish for consumers is protein. The choice of cooking method should be maintained according to protein preservation. Therefore, the boiling process should be best method with protein content 18.25%.

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Conflict of Interest:

The authors declare no conflict of interest.

Ethical Statement:

This article does not contain any studies that would require an ethical statement.

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